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TRANSMITTAL OF APPEAL BRIEF (Large Entity)	Docket No. **OKI.286**

In Re Application Of: **Naokatsu Ikegami**

Serial No.	Filing Date	Examiner	Group Art Unit
09/996,788	**November 30, 2001**	**K. Chen**	**1765**

Invention: **METHOD FOR MANUFACTURING A SEMICONDUCTOR DEVICE**

TO THE COMMISSIONER FOR PATENTS:

Transmitted herewith in triplicate is the Appeal Brief in this application, with respect to the Notice of Appeal filed on **December 18, 2003.**

The fee for filing this Appeal Brief is: **$330.00**

☐ A check in the amount of the fee is enclosed.

☒ The Director has already been authorized to charge fees in this application to a Deposit Account.

☒ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **50-0238**

Signature

Dated: **February 17, 2004**

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	:	Before the Board of Appeals
Naokatsu Ikegami	:	Appeal No.:
Serial No.: 09/996,788	:	Group No.: 1765
Filed: November 30, 2001	:	Examiner: K. Chen

For: METHOD FOR MANUFACTURING A SEMICONDUCTOR DEVICE

Date: February 17, 2004

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APPEAL BRIEF

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Date: February 17, 2004

Sir:

This is an appeal from the final rejection of claims 10-15, which claims were finally rejected in the Office Action dated July 21, 2003. A Notice of Appeal was filed on December 18, 2003.

I. REAL PARTY IN INTEREST

This application is assigned to Oki Electric Industry Co., Ltd., which is the real party in interest.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences that will directly affect or be affected by or have a bearing on the Board's decision in this pending appeal.

III. STATUS OF THE CLAIMS

Claims 10-15 are pending in this application, and the rejection thereof is hereby appealed.

IV. STATUS OF AMENDMENTS

Subsequent to the Final Office Action dated July 21, 2003, Applicant submitted a Request for Reconsideration on September 29, 2003, without amending the pending claims. In the Advisory Action dated October 21, 2003, the Examiner indicated that the rejection under 35 U.S.C. 112 had been overcome in view of the Request for Reconsideration filed September 29, 2003.

V. SUMMARY OF THE INVENTION

The present invention relates to a method of forming a conductive path extending from a surface of an insulating layer on a semiconductor substrate, to a conductive member embedded in the insulating layer. The method prevents formation of a short circuit between the conductive path and a conductive part located beneath the conductive member, that may occur due to mask misalignment.

The semiconductor device as illustrated in Fig. 1(a) is initially made to include semiconductor substrate 22 (silicon for example) having interlayer insulating layer 23 (silicon dioxide for example) thereon. A second conductive member 25 is embedded as a lower electrode member within insulating layer 23. An electrode member 24 (a metal material such as aluminum for example) is also embedded in insulating layer 23, above second conductive member 25 (page 7, lines 11-18).

Before the etching process begins, a resist mask 26 made of a photoresist material is formed on the surface 23a of the structure by photolithography, as illustrated in Fig. 1(b). The opening 26a is formed with a diameter D1 which substantially corresponds to the width of the electrode member 24 (page 7, lines 23-25). If the opening 26a of resist mask 26 is formed at a position where the opening 26a is aligned with electrode member 24, a vertical offset s between opening 26a and electrode member 24 does not occur. In this case, electrode member 24 serves as an etching stopper, so that the etched hole is formed to open in correct alignment with electrode member 24 (page 8, lines 12-18).

In contrast, if the photolithography conditions are such that an offset s caused by misalignment of resist mask 26 occurs as shown in Fig. 1(b), the etched hole 27 in Fig. 1(c) is likely to extend from beyond a periphery of electrode member 24 downward to reach lower electrode member 25 (page 8, lines 19-22). This offset s is indicated in Fig. 1(b) as the rightward portion of opening 26a which is bounded by the inwardly pointing arrows, and which extends in a vertical direction beyond the edge or perimeter

of electrode member 24.

In the present invention, an etching stop condition is created that prevents an etched hole (formed due to mask misalignment) from reaching lower electrode member 25, as shown in Fig. 1(c)(page 8, lines 23-27). Under the etching stop condition, a polymeric product produced by the polymeric film generating action of the etching gas during etching, is deposited in the etched groove formed as corresponding to offset s caused by misalignment of resist mask 26. The etching action and polymerizing action become balanced to eventually manifest the etch stop phenomenon (page 9, lines 4-9), so that etching of the hole stops at depth d (Fig. 1(c)) and so that the etched hole does not extend to lower electrode member 25. Etched hole 27, including the misaligned portion extending downward from a periphery of electrode member 24, may then be filled with a conductive material 32 as shown in Fig. 1(d), with no possibility of the occurrence of a short circuit between conductive material 32 and lower electrode member 25 (page 11, lines 8-10).

From the tendency shown in the graph of Fig. 3, if the permissible placement error of resist mask 26 is limited to 0.04 μm and resist mask 26 is placed properly within this error limit, and if the etching process of insulating layer 23 is carried out under the conditions of reaction chamber pressure of 100 mTorr or higher, while supplying a mixed reaction gas of CHF_3 and CO at a flow ratio of about 15/85, the unaligned portion of etched hole 27 which occurs due to offset s does not reach lower electrode member 25 (page 10, line 21-page 11, line 2). As may be clear from the graph of Fig. 4, the

etching stop phenomenon is observed at a depth of about 100nm from the upper surface of the electrode member 24 under conditions of 200 mTorr reaction chamber pressure with gas flow rates for CHF_3/CO of not less than 300 sccm, such as 45/255 sccm if the offset s of the resist mask 26 is not more than 0.1 micron. Under these conditions, a short circuit can be prevented more securely and a larger permissible placement error can be realized (page 12, lines 11-21).

VI. ISSUES

Claims 10-15 have been rejected under 35 U.S.C. 103(a) as being unpatentable over the Tahara et al. reference (U.S. Patent No. 5,356,515), in view of the Yamada reference (U.S. Patent No. 5,827,778) and the Pu et al. reference (U.S. Patent No. 5,843,847).

Accordingly, one issue presented is whether or not the methods of claims 10-15 are obvious in view of the combined teachings of the Tahara et al., Yamada and Pu et al. references.

VII. GROUPING OF CLAIMS

Applicant respectfully submits that independent claim 10 is separately patentable on its own merits.

Dependent claim 12 which features reaction chamber pressure of not less than 100 mTorr and a high-frequency power of 1600 W, and an offset portion not more than

0.04 μm, is also patentable on its own merits. Dependent claim 14 which features a flow rate of reactive gas not less than 30 sccm, a reaction chamber pressure of not less than 200 mTorr, and an offset portion of not more than 0.1 μm, is also patentable on its own merits. Dependent claims 11, 13 and 15 should be grouped together, and the patentability thereof can be determined with the patentability of claim 10 from which these claims depend.

VIII. ARGUMENTS

Claims 10-15 have been rejected under 35 U.S.C. 103(a) as being unpatentable over the Tahara et al. reference (U.S. Patent No. 5,356,515), in view of the Yamada reference (U.S. Patent No. 5,827,778) and the Pu et al. reference (U.S. Patent No. 5,843,847). This rejection is respectfully traversed for the following reasons.

As described generally on page 9, lines 1-9 of the present application, in the etching process of the invention, the reaction by an etching gas includes an etching action, and a polymerizing action that deposits a polymeric product on the etched portion. The etching gas and conditions are intentionally set in the present invention so that the polymeric product is deposited in the etched groove of Fig. 1(c) which is formed due to mask misalignment. The polymeric product as intentionally deposited in the groove during the etching process acts as an etch stop, so that etching of the groove does not continue all the way through to lower electrode member 25, and so that a short circuit does not occur between conductive material 32 subsequently filled in the

etched hole and lower electrode member 25 shown in Fig. 1(d). Accordingly, in the present invention, the polymeric product is intentionally deposited within the misalignment groove during etching and is used as an etch stop to stop etching of the misalignment groove.

The method of forming a conductive path in a semiconductor device of claim 10 includes in combination "etching a hole in the insulating layer to the conductive member using the etching mask and a reactive gas, the hole including a misalignment groove in the insulating layer at a side of the conductive member that corresponds to the offset portion of the opening in the etching mask" and "stopping a downward extension of said etching of the misalignment groove by using a polymeric product as an etch stop, the polymeric product generated by a polymeric film generating action of the reactive gas during said etching". Applicant respectfully submits that the method of forming a conductive path of claim 10 would not have been obvious in view of the prior art as relied upon by the Examiner.

In column 12, lines 52-65 of the Tahara et al. reference as primarily relied upon by the Office, contact hole 87 is described with reference to Fig. 7B as formed through silicon dioxide layer 82 to poly-Si wiring 85. Contact hole 87 is shown as aligned with wiring 85, so that a misalignment groove is not formed extending downward through silicon dioxide layer 82 along a perimeter of wiring 85. The occurrence of misalignment grooves is not described or even remotely considered in the Tahara et al. reference. That is, the Tahara et al. reference is generally directed to increasing etching rate and

selectivity. Since misalignment grooves are not disclosed or even remotely considered, the Tahara et al. reference clearly fails to disclose or even remotely suggest the need or use of a polymeric product as an etch stop in order to stop etching of a misalignment groove, as featured in claim 10.

In the Yamada reference as secondarily relied upon by the Office, an object is to prevent and/or solve the problem of mask misalignment, whereby a via-hole may protrude beyond a side of an interconnect causing a short-circuit with an underlying interconnect pattern, as generally described in column 4, lines 3-8 and as understood in view of Fig. 1D.

As described beginning in column 2, line 1 of the Yamada reference with respect to Figs. 2A and 2B, a conventional approach uses a reduced time interval for over-etching. A still further conventional approach as described beginning in column 2, line 12 with respect to Figs. 3A-3E of the Yamada reference is to employ a laminated structure, whereby first interlayer insulating film 75 prevents etching from proceeding to the lateral side of first interconnect 74, as particularly illustrated in Fig. 3D. An additional conventional example is described beginning in column 3, line 32 of the Yamada reference with respect to Figs. 4A-4D, wherein however formation of the misalignment groove to substrate 81 is evident without remedy. **Accordingly, the conventional prior art processing methods as described in the Yamada reference are not disclosed or remotely suggested as using a polymeric product formed during etching of a misalignment groove as an etch stop, as featured in claim 10.**

In a preferred embodiment as described with respect to Figs. 5A-5F of the Yamada reference, etching is stopped by first interlayer insulating film 14 as described in column 7, lines 27-40, so that a misalignment groove is not formed. In a preferred embodiment as described with respect to Fig. 7A-7B of the Yamada reference, the misalignment groove is similarly prevented from occurring by use of silicon oxide film 14. In a third preferred embodiment of the Yamada reference as particularly described in column 9, lines 55-59 with respect to Fig. 8C, the etching condition is controlled to increase flourine content, so that a misalignment groove extending into silicon oxide 14 does not occur.

Accordingly, in the preferred embodiments of the Yamada reference, a misalignment groove is prevented from occurring. **Since a misalignment groove is prevented from occurring in the preferred embodiments, the Yamada reference does not disclose or even remotely suggest using a polymeric product formed during etching of a misalignment groove as an etch stop, as featured in claim 10.**

The Pu et al. reference as also secondarily relied upon by the Office is directed to controlling etching selectivity and etch rate microloading. As described beginning in column 1, line 60 of the Pu et al. reference, gas compositions are considered that provide high etching selectivity because dissociated carbon in the etchant gas forms complex polymeric byproducts that deposit as passivating layers on the sidewalls, underlayer and overlayer of the etched features to thereby reduce etching. As particularly described in column 2, lines 5-9 of the Pu et al. reference, although vertical

anisotropic etching is desirable, excessive deposition of passivating polymers on the sidewalls of the etched features **is undesirable.** As further described in column 2, lines 28-32 of the Pu et al. reference, it is desirable for the etching process of the preferred embodiments to provide reduced profile microloading and substantially anisotropic etching by controlling the amount of passivating deposits formed on the sidewalls of the etched features. **In other words, an object of the Pu et al. reference is to prevent excessive deposition of passivating polymers that would result in stopping of the etching.**

In preferred embodiments of the Pu et al. reference, the volumetric flow ratio is selected so that the rate of formation of passivating deposits on etched features of the substrate is approximately equal to the rate of removal of the passivating deposits, as described generally in column 2, lines 51-54. As particularly described in column 6, lines 55-63 of the Pu et al. reference, the nitrogen-containing gas is believed to react with some of the CF_2 radicals to form volatile CN radicals which are exhausted from the process chamber 50. The resultant increase in oxygen species in the plasma zone reacts with free carbon **to reduce the amount of passivating deposits 46** formed on substrate 25, reduce etch rate microloading, and "**prevent** deposition of excessively thick passivating deposit layers **that can stop the etching process**".

Accordingly, the Pu et al. reference is directed to controlling volumetric flow ratios of etching gas **so that excessive passivating deposits are not formed to stop etching.** Since the Pu et al. reference is directed to controlling processing so that

etching can proceed without excessive formation of passivating products, the Pu et al. reference would provide no motivation to create the necessary polymeric products to intentionally stop etching. Applicant respectively submits that one of ordinary skill therefore would not be motivated to modify the corresponding processes of the previous relied upon prior art in view of the Pu et al. reference to use polymeric products formed during etching as an etch stop of a misalignment groove. That is, the Pu et al. reference is concerned with controlling formation of passivating deposits so as to improve etching selectivity and etch rate microloading, not to stop etching of a misalignment groove.

Particularly, the relied upon prior art taken as a whole does not disclose or remotely suggest intentionally using polymeric products formed during etching of a misalignment groove as an etch stop. Since the Pu et al. reference does not use polymeric products to stop etching, the Office has clearly relied upon impermissible hindsight to suggest that doing so in the previously relied upon prior art would have been obvious. This should be evident because formation of misalignment grooves is not described or even remotely considered in the Tahara et al. reference, and because the Yamada reference discloses processing that prevents formation of misalignment grooves (rather than stopping further etching thereof). Accordingly, Applicant respectfully submits that the method of forming a conductive path of claim 10 would not have been obvious in view of the prior art as relied upon by the Office taken singularly or together, and that this rejection of claims 10-15 is improper for at least these

reasons.

On page 2, lines 2-5 of the Advisory Action dated October 21, 2003, the Office has provided the following comments responsive to the arguments presented in the Request for Reconsideration (dated September 29, 2003) with reference to the Tahara et al. reference:

> ". . . the etching mask and the desired location of the hole are never perfectly lined up with each other, it appears that an etched groove is always exist in the etching process and include an offset portion".

Applicant respectfully submits that the Office has failed to appreciate the arguments as presented with respect to the Tahara et al. reference. It should be understood that since the Tahara et al. reference does not specifically disclose or even remotely consider the existence of misalignment grooves, the Tahara et al. reference clearly can provide no motivation or teaching to use polymeric products generated during etching of a misalignment groove as an etch stop, to stop further etching of the misalignment groove. Even assuming for the sake of argument that misalignment could or may hypothetically occur between photoresist 83 and poly-si wiring 85 in Fig. 7B of the Tahara et al. reference, the idea or concept of using polymeric products as an etch stop of such a hypothetical misalignment groove is not disclosed, considered or even remotely suggested. Accordingly, it is irrelevant with respect to the presented

arguments whether misalignment grooves could or hypothetically may occur in the process of the Tahara et al. reference as suggested by the Office, because the use of a polymeric product as an etch stop simply is not disclosed or considered in the Tahara et al. reference.

On page 2, lines 13-17 of the Advisory Action, the Office has provided the following comments responsive to the arguments as further presented in the Request for Reconsideration:

> ". . . It is well-known that the etching process of using carbon-containing etchant gas produces polymeric byproducts as a passivating layer, which deposit on the sidewalls and the bottom of the openings, and Pu clearly addresses that could limit the etching, col. 1, lines 64-col. 2, line 4".

Applicant respectfully concedes that polymeric byproducts are generally known to be used as passivation layers. However, as emphasized in the Request for Reconsideration, the Pu et al. reference is concerned with avoiding the undesirable excessive deposition of passivating polymers that would stop etching. The Pu et al. reference is not directed to intentionally using polymeric byproducts to stop etching of a groove. Accordingly, even though polymeric byproducts may be generally known, the Office has failed to provide a specific teaching, and/or to establish the necessary and clear motivation from any of the relied upon prior art, to specifically use polymeric

byproducts generated during etching of a misalignment groove as an etch stop to prevent further etching of the misalignment groove.

Accordingly, since the relied upon prior art taken singularly or together does not disclose or even remotely suggest the use of polymeric byproducts generated during etching of a misalignment groove as an etch stop to prevent further etching of the misalignment groove, the rejection of claims 10-15 would appear to be based on impermissible hindsight, and thus must be considered improper. Applicant therefore respectfully requests that the rejection of claims 10-15 be withdrawn for at least these reasons.

The method of forming a conductive path of dependent claim 12 features that "said etching is performed in a reaction chamber at a reaction chamber pressure not less than 100 mTorr and a high-frequency power 1600 W, and the offset portion is not more than 0.04 µm". Applicant respectfully submits that the prior art as relied upon by the Office does not disclose a specific embodiment including the processing parameters as featured in claim 12, and particularly does not disclose the use of such processing parameters to create an etch stop phenomenon that stops a downward extension of an etched misalignment groove. Particularly, the prior art references do not intentionally create an etch stop phenomenon, and thus clearly fail to disclose the featured processing parameters as used specifically together. Accordingly, Applicant respectfully submits that the method of forming a conductive path of dependent claim 12 would not have been obvious in view of the prior art as relied upon by the Office

taken singularly or together for at least these reasons.

The method of forming a conductive path of claim 14 features that "a flow rate of the reactive gas during said etching is not less than about 300 sccm, said etching is performed in a reaction chamber at a reaction pressure not less than 200 mTorr, and the offset portion is not more than 0.1 μm". Applicant respectfully submits that the prior art as relied upon by the Office does not disclose a specific embodiment including the processing parameters as featured in claim 14, and particularly does not disclose the use of such processing parameters to create an etch stop phenomenon that stops a downward extension of an etched misalignment groove. Particularly, the prior art references do not intentionally create an etch stop phenomenon, and thus clearly fail to disclose the featured processing parameters as used specifically together. Accordingly, Applicant respectfully submits that the method of forming a conductive path of dependent claim 14 would not have been obvious in view of the prior art as relied upon by the Office taken singularly or together for at least these further reasons.

VIV. <u>Conclusion</u>

Favorable consideration and allowance of all claims by the Honorable Board of Patent Appeals and Interferences is respectfully requested.

The required fee of $330.00 under 37 C.F.R. 1.17(c) for filing this Appeal Brief is attached hereto.

In the event that there are any outstanding matters remaining in the present

application, please contact Andrew J. Telesz, Jr. (Reg. No. 33,581) at (703) 715-0870 in the Washington, D.C. area, to discuss these matters.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment for any additional fees that may be required, or credit any overpayment, to Deposit Account No. 50-0238.

Respectfully submitted,

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CLAIMS APPENDIX

Claim 10. A method of forming a conductive path in a semiconductor device, the conductive path to extend from an upper surface of an insulating layer of silicon dioxide formed on a silicon substrate to a conductive member embedded in the insulating layer, the method comprising:

forming an etching mask on the insulating layer, the etching mask having an opening over the conductive member and the opening being misaligned to include an offset portion extending beyond the conductive member;

etching a hole in the insulating layer to the conductive member using the etching mask and a reactive gas, the hole including a misalignment groove in the insulating layer at a side of the conductive member that corresponds to the offset portion of the opening in the etching mask;

stopping a downward extension of said etching of the misalignment groove by using a polymeric product as an etch stop, the polymeric product generated by a polymeric film generating action of the reactive gas during said etching; and

filling the hole and the misalignment groove with a conductive material to form the conductive path.

Claim 11. The method of forming a conductive path of claim 10, wherein the reactive gas during said etching is a compound gas of CHF_3/CO having a flow ratio of about 15/85.

Claim 12. The method of forming a conductive path of claim 11, wherein said etching is performed in a reaction chamber at a reaction chamber pressure not less than 100mTorr and a high-frequency power of 1600W, and the offset portion is not more than 0.04μm.

Claim 13. The method of forming a conductive path of claim 12, wherein flow rates of the CHF_3 gas and the CO gas during said etching are respectively about 30 sccm and about 170 sccm.

Claim 14. The method of forming a conductive path of claim 11, wherein a flow rate of the reactive gas during said etching is not less than about 300 sccm,

said etching is performed in a reaction chamber at a reaction pressure not less than 200mTorr, and the offset portion is not more than 0.1μm.

Claim 15. The method of forming a conductive path of claim 14, wherein flow rates of the CHF_3 gas and the CO gas during said etching are respectively about 45 sccm and about 255 sccm.